

Claims:

1. An image transform method comprising:

transforming original input image data into image data
expanded by a ratio represented by a rational number or an
5 integer, including the steps of:

reducing correlation in the vertical and horizontal
directions of an image that is linearly expanded in the
vertical and horizontal directions to generate first
expanded image data;

10 performing linear interpolation, based on correlation
with a target pixel constituting said original image data
and neighboring pixels arranged in oblique directions, using
said neighboring pixels to generate second expanded image
data; and

15 employing said first expanded image data and said
second expanded image data to generate a final image.

2. The image transform method according to claim 1, wherein
said step of generating said first expanded image data
includes the steps of:

20 raster-scanning a window having a predetermined size
wherein a target pixel and its neighboring pixels in the
linearly expanded image data are included; and

reducing vertical and horizontal directional
correlation through a rank order processing in the window.

3. The image transform method according to claim 1, wherein said step of generating said second expanded image data includes the steps of:

determining an interpolation direction based on values of differences between said target pixel and said neighboring pixels; and

performing linear interpolation in said interpolation direction.

4. The image transform method according to claim 1, further comprising the step of:

regarding, as an adjustment value, the personal preference of a user concerning image quality,

wherein, at said step of generating said final image, based on said adjustment value, said final image is generated by using said first and said second expanded image data.

5. An image transform method comprising:

transforming original input image data into image data expanded by a ratio represented by a rational number or an integer, including the steps of:

forming an image by linearly expanding original image data in the vertical and horizontal directions; and

reducing the vertical and horizontal directional correlation of said image through a rank order processing to generate a final expanded image.

6. The image transform method according to claim 5, further comprising the steps of:

determining, for said expanded image, whether the contrast in said original image data can be maintained at a predetermined level; and

extracting a high frequency component from said expanded image, when said contrast can not be maintained at said predetermined level, and adding said frequency component multiplied by a constant to said expanded image, or subtracting said frequency component multiplied by a constant from said expanded image.

7. An image transform method comprising:

transforming original input image data into image data expanded by a ratio represented by a rational number or an integer, including the steps of:

reading a target pixel and neighboring pixels thereof in original image data;

employing said target pixel and said neighboring pixels to calculate directional differences for the right oblique and the left oblique directions;

employing said directional differences to determine a strong correlated direction; and

performing linear interpolation for said target pixel using said neighboring pixels arranged in said strong correlated direction.

8. The image transform method according to claim 7, further

comprising the steps of:

reading peripheral pixels arranged within a predetermined mask range adjacent to said target pixel and/or said neighboring pixels; and

5 accumulating differences between said peripheral pixels, and between said target pixel and said neighboring pixels; and

determining an interpolation direction, based on the cumulative value of said differences, and performing interpolation in said interpolation direction.

9. An image transform method comprising:

an input step of entering original image data to be expanded by a magnification of two or more;

a first process step of reducing the step-shapes or chain-shapes of oblique lines appearing when said original image data are expanded by doubled or greater in size;

a second process step of expanding, in the oblique direction, the structure of said original image data, and reducing a bulging shape appearing when a portion is expanded whereat vertical and horizontal lines of said original image data cross each other; and

an output step of outputting an image expanded by said magnification of two or more using said first and second process steps.

25 10. An image processing apparatus comprising:

input means for entering original image data to be expanded;

vertical and horizontal directional interpolation means for interpolating said original image data in the vertical and horizontal directions;

vertical and horizontal directional correlation
5 reduction means for reducing correlation of the obtained image in the vertical and horizontal directions;

oblique direction detection means for detecting an oblique direction having a strong correlation with a target pixel and neighboring pixels in said original image data;
10 and

directional interpolation means for employing said neighboring pixels in said detected oblique direction to perform interpolation in said oblique direction.

11. The image processing apparatus according to claim 10,
15 further comprising:

generation means for generating expanded image data based on an image obtained by said vertical and horizontal directional correlation reduction means and an image obtained by said oblique directional interpolation means.

20 12. The image processing apparatus according to claim 11, further comprising:

input means for entering, as an adjustment value, the personal preference of a user concerning image quality,

wherein said generation means employs said adjustment
25 value to synthesize said image obtained by said vertical and horizontal directional correlation reduction means with said image obtained by said oblique directional interpolation

means.

13. The image processing apparatus according to claim 10,
wherein said vertical and horizontal directional correlation
reduction means performs the ranked median value selection,
5 for the target pixel and its neighboring pixels in the
linearly expanded image data, and thereby reduces the
correlation of an image in the vertical and horizontal
direction.

14. The image processing apparatus according to claim 10,
wherein said oblique direction detection means employs
differences between said target pixel and said neighboring
pixels to detect, with strong correlation, said oblique
direction, and said oblique directional interpolation means
performs linear interpolation in said oblique direction
15 detected by said oblique direction detection means.

15. An image processing apparatus comprising:

a vertical and horizontal directional linear
interpolation unit for forming an image by linearly
expanding original image data in the vertical and horizontal
20 directions; and

a vertical and horizontal directional correlation
reduction processing unit for reducing, for said image, a
vertical and horizontal directional correlation using a rank
order processing to generate a final expanded image,

25 operating in combination for transforming the original input

image data into expanded image data.

16 . An image processing apparatus comprising:

an interpolation direction determination unit for
reading a target pixel and neighboring pixels in original
5 image data, for calculating directional differences between
said target pixel and said neighboring pixels for right
oblique and left oblique directions, and for determining an
interpolation direction based on said directional
differences; and

an oblique directional linear interpolation unit for
performing linear interpolation for said target pixel by
using said neighboring pixels arranged in said determined
interpolation direction,

operating in combination to transform the original input
15 image data into expanded image data.

17. The image processing apparatus according to claim 16,
wherein said interpolation direction determination unit
reads peripheral pixels arranged within a predetermined mask
range adjacent to said target pixel and/or said neighbor
20 pixels and adds together the differences between said
peripheral pixels and said target pixel and said neighbor
pixels, and determines said interpolation direction based on
the cumulative value of said differences.

18. An image display device comprising:

25 first image expansion means for reducing the

step-shapes or chain-shapes of oblique lines in said original color image data, and for outputting an expanded image wherein the vertical and horizontal structure is maintained;

5 second image expansion means for expanding the structure of said original color image data in the oblique direction, for reducing a bulging shape that appears at intersections of lines, and for outputting an expanded image; and

10 display means for employing said expanded images obtained by said first and said second image expansion means to display a final image,

operating in combination to transform low-resolution original color image data into high-resolution expanded color image data, and for outputting said high-resolution expanded color image data.

15 19. The image display device according to claim 18, wherein said original color image data includes thin lines obtained by anti-aliasing, and said second image expansion means
20 performs interpolation based on pixels constituting the original thin lines, not based on pixels obtained by anti-aliasing.

25 20. An article of manufacture comprising a computer usable medium having computer readable program code means embodied therein for causing image transformation, the computer readable program code means in said article of manufacture

comprising computer readable program code means for causing a computer to effect the steps of claim 1.

21. An article of manufacture comprising a computer usable medium having computer readable program code means embodied
5 therein for causing image transformation, the computer readable program code means in said article of manufacture comprising computer readable program code means for causing a computer to effect the steps of claim 5.

22. An article of manufacture comprising a computer usable medium having computer readable program code means embodied
10 therein for causing image transformation, the computer readable program code means in said article of manufacture comprising computer readable program code means for causing a computer to effect the steps of claim 7.

23. An article of manufacture comprising a computer usable medium having computer readable program code means embodied
15 therein for causing image transformation, the computer readable program code means in said article of manufacture comprising computer readable program code means for causing a computer to effect the steps of claim 9.

24. A program storage device readable by machine, tangibly embodying a program of instructions executable by the machine to perform method steps for image transformation, said method steps comprising the steps of claim 1.

25. A program storage device readable by machine, tangibly embodying a program of instructions executable by the machine to perform method steps for image transformation, said method steps comprising the steps of claim 5.

5 26. A program storage device readable by machine, tangibly embodying a program of instructions executable by the machine to perform method steps for image transformation, said method steps comprising the steps of claim 7.

10 27. A program storage device readable by machine, tangibly embodying a program of instructions executable by the machine to perform method steps for image transformation, said method steps comprising the steps of claim 9.

15 28. A computer program product comprising a computer usable medium having computer readable program code means embodied therein for causing image processing, the computer readable program code means in said computer program product comprising computer readable program code means for causing a computer to effect the elements of claim 10.

20 29. A computer program product comprising a computer usable medium having computer readable program code means embodied therein for causing image processing, the computer readable program code means in said computer program product comprising computer readable program code means for causing a computer to effect the elements of claim 15.

30. A computer program product comprising a computer usable medium having computer readable program code means embodied therein for causing image processing, the computer readable program code means in said computer program product

5 comprising computer readable program code means for causing a computer to effect the elements of claim 16.

31. A computer program product comprising a computer usable medium having computer readable program code means embodied therein for causing image processing, the computer readable program code means in said computer program product
10 comprising computer readable program code means for causing a computer to effect the elements of claim 18.